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Vol. III NOVEMBER, 1916 No. 9

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PROCEEDINGS

NOTICE OF REGULAR MEETING.

A REGULAR meeting of the Boston Society of Civil Engineers will be held on

WEDNESDAY, NOVEMBER 15, 1916,

at 8 o'clock P.M., in CHIPMAN HALL, TREMONT TEMPLE, BOSTON.

Mr. Nathan C. Grover will present a paper entitled, " Effect of Channel on Stream Flow."

S. E. TINKHAM, *Secretary.*

PAPERS IN THIS NUMBER.

" Effect of Channel on Stream Flow." Nathan C. Grover.
Memoirs of deceased members.

CURRENT DISCUSSION.

Paper.	Author.	Published.	Discussion Closes.
" Groined Arch Floor Construction."	H. W. Brown.	Oct.	Dec. 10.

Reprints from this publication, which is copyrighted, may be made provided full credit is given to the author and the Society.

Contributors are hereby notified that proof will not be submitted to them for examination unless requested before the 10th of the month preceding the month of publication.

MINUTES OF MEETING.

Boston, Mass., October 18, 1916. — A regular meeting of the Boston Society of Civil Engineers was held this evening in Chipman Hall, Tremont Temple, and was called to order at 8.15 by the President, Richard A. Hale.

There were present 60 members and visitors.

By vote, the record of the last meeting was approved as printed in the October Journal.

The President reported for the Board of Government the election of the following to membership in the Society in the grade of member:

Frank Charles Bell and William Newell Wade.

The Secretary presented the memoir of Emory A. Ellsworth, prepared by a committee consisting of James L. Tighe and Albert H. Lavalle, and by vote it was accepted and ordered to be printed in the Journal.

The Secretary also announced the death of Frank E. Shedd, a member of the Society, which occurred on September 22, 1916. By vote, the President was requested to appoint a committee to prepare a memoir. The President has named, as that committee, Mr. Charles T. Main.

The Secretary read a communication from the Massachusetts Civil Service Commission, asking the coöperation of this Society in a revision of its rules and in its consideration of a new classification of civil engineers, as applied to that service.

By vote, the President was requested to appoint a committee, as suggested in the communication. The President has selected the following as the membership of that committee: Frederick H. Fay, Charles R. Gow, Rufus M. Whittet, John E. Carty and Edwin H. Rogers.

Mr. H. Whittemore Brown then presented the paper of the evening, entitled, "The Groined Arch as a Means of Concrete Floor Construction," which is printed in the October number of the Journal. The reading of the paper was illustrated by lantern slides.

The paper was discussed by Past President Gow and Messrs. F. L. Fuller, J. R. Nichols, H. W. Hayward and others.

Adjourned.

S. E. Tinkham, *Secretary.*

APPLICATIONS FOR MEMBERSHIP.

[November 4, 1916.]

The By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

Breen, Anthony Andrew, Somerville, Mass. (Age 21, b. Somerville, Mass.) Received technical education in evening courses at Wentworth Institute and Franklin Union, where he completed three years' course in structures, March, 1915. From June, 1911, to June, 1914, junior draftsman with Boston Elevated Railway Co., Architectural Division; from July to Oct., 1914, with Stone & Webster, detailing reinforced concrete; from Feb. to Dec., 1915, draftsman with Hub Wire Cloth & Wire Work Company; from Jan., 1916, to date, estimator with same concern. Refers to E. H. Rockwell, R. C. Smith, F. S. Wells and J. M. Wiseman.

Bresth, Alexander, Boston, Mass. (Age 22, b. East Boston, Mass.) Graduate of Mass. Inst. of Technology, 1916, sanitary engineering course. Is now assistant sanitary engineer with Massachusetts State Department of Health. Refers to H. E. Holmes, Dwight Porter, C. M. Spofford, G. C. Whipple and Edward Wright, Jr.

Bryant, William Allen, Brookline, Mass. (Age 26, b. Brookline, Mass.) Completed five-year course in civil engineering at Mass. Inst. of Technology, degree of S.B. During summers worked as rodman and transitman with H. F. Bryant, Brookline; in 1914, resident engineer with L. D. Thorpe, Boston, on construction of concrete dam; from spring of 1915 to date, in charge of office of H. F. Bryant. Elected a Junior December 20, 1911, and now desires to be transferred to grade of member. Refers to

C. F. Allen, H. F. Bryant, A. E. Burton, C. M. Spofford and S. E. Tinkham.

CROSIER, CHARLES LEAVETT, Boston, Mass. (Age 21, b. Hadley, Mass.) Graduate of Mass. Inst. of Technology, 1916, sanitary engineering course. Is now assistant in civil engineering at Mass. Inst. of Technology. Refers to H. K. Barrows, G. L. Hosmer, J. W. Howard, Dwight Porter, C. M. Spofford and G. C. Whipple.

KNOWLTON, ARTHUR WILLIAM, Rockport, Mass. (Age 26, b. Boston, Mass.) Graduate of Worcester Polytechnic Inst., 1914, degree of B.S. in civil engineering. From July, 1914, to Aug., 1915, assistant bridge inspector, fourth division, B. & M. R. R.; from Aug., 1915, to date, bridge inspector, first division, B. & M. R. R. Elected a Junior January 27, 1915, and now desires to be transferred to grade of member. Refers to C. M. Allen, B. W. Guppy, E. A. Norwood and H. P. Wires.

NOLAN, CONRAD, Somerville, Mass. (Age 25, b. Jacksonville, Fla.) Graduate of Tufts College, 1913, structural engineering course. During summer of 1910, timekeeper with Charles R. Gow Co., Boston, on concrete sewer in West Roxbury; during summers of 1911 and 1912, and from June, 1913, to date, with G. M. Bryne Co., general contractors, on concrete bridge construction and on sewer construction, including four sections of Metropolitan sewer.. Elected a Junior January 25, 1911, and now desires to be transferred to grade of member. Refers to C. R. Gow, E. S. Larned, C. A. Leary, E. H. Rockwell, F. B. Sanborn and F. D. Smith.

STROUT, HENRY ELMER, Jr., Roxbury, Mass. (Age 22, b. Roxbury, Mass.) Student at Mass. Inst. of Technology, class of 1917, engineering administration course. During summer of 1916 with Aberthaw Construction Company. Refers to C. B. Breed, G. L. Hosmer, H. B. Luther and C. M. Spofford.

VAN DER PYL, EDWARD, Worcester, Mass. (Age 28, b. Worcester, Mass.) Student with American School of Correspondence from 1909 to date, courses in advanced mathematics, bridge engineering and steel construction. From Dec., 1906, to July, 1907, apprentice machinist with F. E. Reed Machine Tool Co.; from July to Oct., 1907, draftsman with Worcester Envelope Co.; from Oct., 1907, to Jan., 1909, designer for Reed & Prince Mfg. Co.; from Jan., 1909, to date, with engineering department of Norton Company, as draftsman and designer and, since Aug., 1916, inspector of construction. Refers to A. W. French, H. L. Robinson and J. A. Tosi.

LIST OF MEMBERS.

ADDITIONS.

BELL, FRANK C.	23 Spring St., Malden, Mass.
FORD, ARTHUR L.	28 Evelyn Place, Malden, Mass

CHANGES OF ADDRESS.

Ackerman, Alexander S. . . . . .64 Seminary Ave., Rahway, N. J.
Babbitt, John H., Mass. Inst. of Technology Dormitories, Cambridge, Mass.
Babcock, Paul A. . . . . .557 Adams St., East Milton, Mass.
Bowers, George W. . . . . .4008 Prospect Ave., Cleveland, Ohio
Chevalier, Charles R. . . . . .64 Dartmouth St., Portland, Me.
Foster, Howard L. .1137 Mass. Ave., Cambridge, Mass.
French, Herman W. . . . . .701–2 Tremont Building, Boston, Mass.
Hammatt, Edward A. W. . . . . .South Orleans, Mass.
Hodges, Arthur W. . . . . .46 West Rosseter St., Brockton, Mass.
Joy, C. Frederick, Jr. . . . . .187 Reedsdale Road, Milton, Mass.
Morrison, Harry J. . . . . .Box 197, Beckley, W. Va.
Shorrock, John W. . . . . .Box 17, Milton, N. H.
Skillin, Fred B. . . . . .4415 8th St. N. W., Washington, D. C.
Smith, Edward R. . . . . .26 Hancock St., Malden, Mass.
Taylor, Philip W. . . . . .115 Beech St., Waverly, Mass.
Tisdale, Ellis S. . . . . .State Department of Health, Charleston, W. Va.
Wells, Charles E. .7 Prospect St., White Plains, N. Y.
Whiting, Mason T. . . . . .Holter, Mont.
Whitney, Ralph E., 191 Powder House Boulevard, West Somerville, Mass.

DEATHS.

Bolton, Edward D. . . . . .March 10, 1916
Cuntz, William C. . . . . .November 2, 1916
Ellis, John W. . . . . .October 30, 1916

EMPLOYMENT BUREAU.

The Board of Government maintains an employment bureau for the Society, to be a medium for securing positions for its members and applicants for membership, and also for furnishing employees to members and others desiring men capable of filling responsible positions.

At the Society room two lists are kept on file, one of *positions available* and the other of *men available,* giving in each case detailed information in relation thereto.

Men Available.

No. 375. Age 22. Student for two years at Mass. Agricultural College. Has had no practical experience. Desires position as rodman.

No. 376. Age 20. Graduate of Lowell Inst. School for Industrial Foreman, 1916, buildings course. Has had four years' experience as rodman, transitman, draftsman, etc., with town engineering department. Desires position as transitman or draftsman. Salary desired, $16 to $18 per week.

No. 377. Age 24. Student for one year at Mechanic Arts Evening School, one year at Y. M. C. A., and one year at Franklin Union. Has had about five years' experience, chiefly as rodman and transitman, on laying out of sewers, preliminary survey for water power development, etc. Desires position as chief of party or inspector on sewer work. Salary desired, $100 per month.

LIBRARY NOTES.

Recent Additions to the Library.

U. S. Government Reports.

Accidents at Metallurgical Works in United States during Calendar Years 1913 and 1914. Albert H. Fay.

Analysis of Permissible Explosives. C. G. Storm.

Bauxite and Aluminum in 1915. W. C. Phalen.

Bibliography of North American Geology for 1915 with Subject Index. John M. Nickles.

Black Damp in Mines. G. A. Burrell and others.

Brass-Furnace Practice in United States. H. W. Gillett.

Casting of Clay Wares. Taine G. McDougal.

Catahoula Sandstone and Its Flora. George Charlton Matson and Edward Wilber Berry.

Cement in 1915. Ernest F. Burchard.

Condensation of Gasoline from Natural Gas. George A. Burrell and others.

Compressibility of Natural Gas at High Pressures. G. A. Burrell and I. W. Robertson.

Construction and Operation of Single-Tube Cracking Furnace for Making Gasoline. C. P. Bowie.

Determination of Nitrogen in Coal. Arno C. Fieldner and Carl A. Taylor.

Economic Methods of Utilizing Western Lignites. E. J. Babcock.

Effects of Atmospheres Deficient in Oxygen on Small Animals and on Men. George A. Burrell and G. G. Oberfell.

Effects of Temperature and Pressure on Explosibility of Methane-Air Mixtures. G. A. Burrell and I. W. Robertson.

Electric Furnace in Metallurgical Work. Dorsey A. Lyon and others.

Electric Furnaces for Making Iron and Steel. Dorsey A. Lyon and Robert M. Keeney.

Explosibility of Acetylene. George A. Burrell and G. G. Oberfell.

Explosibility of Gases from Mine Fires. George A. Burrell and George G. Oberfell.

Production of Explosives in United States during Calendar Year 1915. Albert H. Fay.

Extraction and Recovery of Radium, Uranium and Vanadium from Carnotite. Charles L. Parsons and others.

Feldspars of New England and North Appalachian States. A. S. Watts.

Gasoline Mine Locomotives in Relation to Safety and Health. O. P. Hood and R. H. Kudlich.

Hazards in Handling Gasoline. George A. Burrell.

Health Conservation at Steel Mills. J. A. Watkins.

Inflammability of Illinois Coal Dusts. J. K. Clement and L. A. Scholl, Jr.

Lime in 1915. G. F. Loughlin.

Limits of Inflammability of Mixtures of Methane and Air. G. A. Burrell and G. G. Oberfell.

Manufacture and Uses of Alloy Steels. Henry D. Hibbard.

Metal-Mine Accidents in United States during Calendar Year 1914. Albert H. Fay.

Preservative Treatment of Farm Timbers. George M. Hunt.

Some Properties of Water in Coal. Horace C. Porter and O. C. Ralston.

Quantity of Gasoline Necessary to Produce Explosive Conditions in Sewers. G. A. Burrell and H. T. Boyd.

Quarry Accidents in United States during Calendar Year 1914. Albert H. Fay.

Sand and Gravel in 1915. R. W. Stone.

Salt, Bromine, and Calcium Chloride in 1915. W. C. Phalen.

Sand Test for Determining Strength of Detonators. C. G. Storm and W. C. Cope.

Shot Firing in Coal Mines by Electricity Controlled from Outside. H. H. Clark and others.

Water-Supply Paper 362-B.

State Reports.

New York. Annual Report of State Department of Health for 1914.

Municipal Reports.

Bangor, Me. Annual Report of Water Board for 1915.

New York, N. Y. Annual Report of Board of Water Supply for 1915.

Newton, Mass. Annual Report of Water Commissioner for 1915.

Providence, R. I. Annual Report of City Engineer for 1915.

Miscellaneous.

American Institute of Mining Engineers: Transactions for 1916, Vols. LII and LIII.

Brooklyn Engineers' Club: Proceedings for 1915.

Construction of Roads and Pavements. T. R. Agg.

Hydrated Lime Bureau: Dependable Concrete.

Portland Cement Association: Concrete Feeding Floors, Barnyard Pavements and Concrete Walks; Concrete Fence Posts; Concrete Foundations; Concrete in the Country; Proportioning Concrete Mixtures and Mixing and Placing Concrete; Small Concrete Garages.

Two Hundred Power Plant Pointers.

The magazines, reports, etc., in the following list are duplicate copies for which the Society has no room in its library. They have been placed on the ends of the tables in the reading room, and members desiring any of them for their own files are at liberty to help themselves. After a reasonable length of time, those remaining will be otherwise disposed of. Similar lists will be published in the JOURNAL from time to time:

American Architect: June 14, 1911.

American Society of Civil Engineers: Transactions and Proceedings, August–November, 1895; Transactions, July and December, 1896; December, 1909; March, June, October and December, 1910; March, June, September and December, 1911; December, 1912; December, 1913; December, 1914; Vols. LXXVIII and LXXIX, 1915; Proceedings, January and March, 1897; September, 1909; January–September, November, December, 1910; January, March–May, September, November, December, 1911; January–November, 1912; January, April–December, 1913; Index to Transactions, Vols. I–LXXIV, 1867–1911. Electrification of Suburban Zone of New York Central and Hudson River R. R. in Vicinity of New York City, by William J. Wilgus, 1908. Some Tendencies and Problems of the Present Day and the Relation of the Engineer Thereto, by George Fillmore Swain, 1913. Maximum Rates of Rainfall, by Desmond FitzGerald, 1889. Inland Sewage Disposal with Special Reference to East Orange, N. J., Works, by Carrol Ph. Bassett, 1891.

American Society of Mechanical Engineers: Journal, February and October, 1914.

Association of Engineering Societies: Journal, Vols. 2, 1882–83; 3, 1883–84; 22, 1899; cloth binding.

Association of American Portland Cement Manufacturers: Concrete in the Country; Concrete Silos; Concreting in Winter; Portland Cement Stucco.

Book of Truth and Facts. Fritz von Frantzius.

Canadian Engineer: March 26, 1914.

Connecticut Society of Civil Engineers: Proceedings, 1886–88; 1890–97; 1907.

Electric Railway Journal: July 4 and 11, 1914.

Electrical World: July 21, 1910; March 15, 1913.

Engineering (Lond.): January 1, 1915.

Engineering and Contracting: March 19, 1913.

Engineering Magazine: April–June, 1912; February and May, 1913; June–December, 1915; January–October, 1916.

Engineering News: March 16–June 29, 1893; May 31, 1894; April 21, 1898; July 24, 1913; title page and index, Vol. 69, January–June, 1913.

Engineering Record: April 3–10, 1915.

Engineers' Society of Western Pennsylvania: Proceedings, January, 1911; December, 1912.

History of Introduction of Pure Water into City of Boston, compiled by Member of Water Board, 1868.

Institution of Civil Engineers (Lond.): Minutes of Proceedings, Vols. 151–168, Part 1, 1902–03, to Part 2, 1906–07; Vols. 170–184, Part 4, 1906–07, to Part 2, 1910–11; Vols. 186–198, Part 4, 1910–11, to Part 4, 1913–14; Vols. 200–201, Part 2, 1914–15, to Part 1, 1915–16.

Iowa State College Engineering Experiment Station: Bulletins 30, Determination of Internal Temperature Range in Concrete Arch Bridges, by C. S. Nichols and C. B. McCullough; 31, Theory of Loads on Pipes in Ditches and Tests of Cement and Clay Drain Tile and Sewer Pipe, by A. Marston and A. O. Anderson.

Mass. Inst. of Technology: Contributions from Sanitary Research Laboratory and Sewage Experiment Station, Vols. 3–6, 8.

Municipal Engineering: May–June, 1915.

Municipal Journal: July 1–22, August 26, September 2, 1915.

National Geographic Magazine: October–December, 1913; January–December, 1914; January–April, 1915.

New England Water Works Association: Transactions for 1883; Journal, September, 1886; September, 1892; June, 1896; December, 1902; March and June, 1903; December, 1912; Report of Committee Appointed to Collect Data Relating to Awards for Water and Water-Power Diversion, December, 1909.

Railway Age Gazette: March 20, April 24, May 1, 1914; January 8–May 28, 1915.

School of Mines Quarterly: November, 1913.

Tables of Astronomical and Trigonometrical Survey of Massachusetts (Borden's Survey of Massachusetts), 1846.

University of Wisconsin Bulletin: Vol. 4, Nos. 2–6; Vol. 5, complete, with title page and table of contents; Vol. 6, complete, with title page and table of contents; Vol. 7, No. 1.

Water-Supply Papers of U. S. Geological Survey: Nos. 1, 65, 200, 201, 234, 373.

LIBRARY COMMITTEE.

NEW ENGINEERING WORK.

(Under this head a brief description of new engineering work contemplated or under construction will be presented each month. Engineers and contractors are requested to send descriptions of their work to the Secretary, 715 Tremont Temple, Boston, before 1st of each month.)

United States Government. — NAVY DEPARTMENT. — *Work in Progress.* — Extension of shipbuilding ways, Navy Yard, Boston, construction of magazine and shell house at Hingham, and rubble sea wall, Naval Hospital, Chelsea.

Commonwealth of Massachusetts. — METROPOLITAN PARK COMMISSION. — The following work is in progress:

Alewife Brook Parkway.—Surfacing and finishing Alewife Brook Parkway, from Massachusetts Ave. to Powder House Boulevard.

Charles River Reservation.—Building reinforced concrete bridge over the Charles River at North Beacon St., Boston and Watertown, A. G. Tomasello, contractor; and reinforced concrete bridge over the Charles River at Commonwealth Ave., Newton and Weston. T. Stuart & Son Company, contractor.

Mystic Valley Parkway.—Grading extension of Mystic Valley Parkway from Mystic St. to Medford St., Arlington. James H. Farnum, contractor.

Nantasket Beach Reservation.—Building concrete retaining and bulkhead walls southeasterly from roller-coaster. Hugh Nawn Contracting Company, contractor.

Old Colony Parkway.—Plans are being prepared for bridge over Neponset River, Boston and Quincy, to replace old wooden bridge.

Boston Transit Commission. — *Dorchester Tunnel.* — The status of this work remains as described in the JOURNAL for October.

City of Boston. — PUBLIC WORKS DEPARTMENT, HIGHWAY DIVISION, PAVING SERVICE. — Work is in progress on the following streets:

Washington St.,	Morton St. to Asticou Rd.	Granite block.
Ripley Rd.,	Harvard St. to Vassar St.	Asphalt.
Upland Ave.,	Park St. to Melville Ave.	Asphalt.
Augustus Ave.,	Metropolitan Ave. to Ethel St.	Bituminous macadam.
Albany St.,	Dover St. to Northampton St.	Granite block.
Everton St.,	Geneva Ave. to Olney St.	Asphalt.
Orchardfield St.,	Dorchester Ave. to Freeport St.	Asphalt.
Cedric St.,	Magazine St. to Langdon St.	Asphalt.
Dunster Rd.,	Centre St. to Pond St.	Asphalt.
Columbia Rd.,	Edward Everett Sq. to Dudley St.	Granite block.
Dorchester Ave.,	Savin Hill Ave. to Freeport St.	Granite block.
Batterymarch St.,	Franklin St. to Broad St.	Granite block.
Hubert St.,	Westminster St. to Shawmut Ave.	Asphalt.
Hillcrest St.,	Elgin St. to Temple St.	Asphalt.
Lorette St.	Centre St. to Hillcrest St.	Asphalt.
Temple St.,	Ivory St. to Spring St.	Asphalt.
Bardwell St.,	South St. to Ballard St.	Asphalt.
Crown Path,	Washington St. to Claybourne St.	Artificial steps.
Homestead St.,	Humboldt Ave. to Elm Hill Ave.	Asphalt.
Alexander St.,	Bird St. to 527 ft. northerly.	Granite block.
Morton St.,	Norfolk St. to N. Y., N. H. & H. R. R.	Artificial walks.
School St.,	Tremont St. to Washington St.	Granite block.
Eric Ave.,	Savin Hill Ave. northerly.	Asphalt.
Appleton St.,	Berkeley St. to Columbus Ave.	Asphalt.
Chandler St.,	Berkeley St. to Columbus Ave.	Asphalt.

Boston Elevated Railway Company. — BUREAU OF ELEVATED AND SUBWAY CONSTRUCTION. — *Everett Extension.* — *Mystic River Bridge.* On this work the large piers at the draw opening are now being constructed. A steel sheet pile cofferdam 122 ft. by 19 ft. has been completed and the work of laying the concrete seal in the bottom of this cofferdam is under way. The top of this concrete mat is to be at approximately grade 76, to which elevation the cofferdam is to be unwatered, and the balance of the work to high water done in the dry. For the adjacent piers, concrete caissons or boats are to be sunk on top of the piles cut to the proper elevation. All of the concrete above the bottom where the caissons are used is done in the dry. The largest of the three caissons which form the last mentioned piers has been cast, and is now on the ways where the sides are to be attached. This caisson or concrete boat is 124 ft. long, 16½ ft. wide and 4 ft. deep, and the first set of wooden sides which are to be attached are 17 ft. in height. This caisson will probably be launched at an early date next month.

Malden Bridge. On the reconstruction of Malden Bridge, which work is being done simultaneously with the railway company's bridge, the heavy sea wall along the westerly line of Alford St. as relocated is now nearing completion and the fill for widening the new street will probably be begun within a short time.

Egleston Square. — Foundations for the steel shelter and the supports for the escalator are completed. Steel for the entire shelter is being erected and the contract for the balance of the carpenter and concrete work has been let to Ira G. Hersey & Sons Co. An escalator having a lift of about 30 ft. is to be installed by the Otis Elevator Co.

The Fore River Shipbuilding Co., Quincy, Mass., has the following work in progress:

New pattern and joiner shop, and new hospital and employment building nearly completed.

Vol. III NOVEMBER, 1916 No. 9

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications

EFFECT OF CHANNEL ON STREAM FLOW.

BY NATHAN C. GROVER,* MEMBER BOSTON SOCIETY OF CIVIL ENGINEERS.

THE engineers of the United States Geological Survey, in their work of collecting records of run-off of surface streams in all parts of the country, have established, maintained and operated gaging stations under widely varying conditions, the variations including size and regimen of streams, character of channel, facilities for transportation of men and materials, local assistants, climate, probable use of the water and degree of accuracy needed in the records. From this experience they have slowly acquired a knowledge of the fundamental requirements of systematic stream-gaging, a knowledge which has been made and is gradually being made a basis for field practice. Though many conditions may affect the cost and continuity of the records, the conditions of channel are of maximum importance in their effect on the cost and accuracy of the record. In considering such effect, distinction should be made between conditions at the gaging site and those in the channel below.

The channel and the current at the gaging site affect the accuracy of the discharge measurement and therefore the definition of the rating curve. The " control " of a gaging station,

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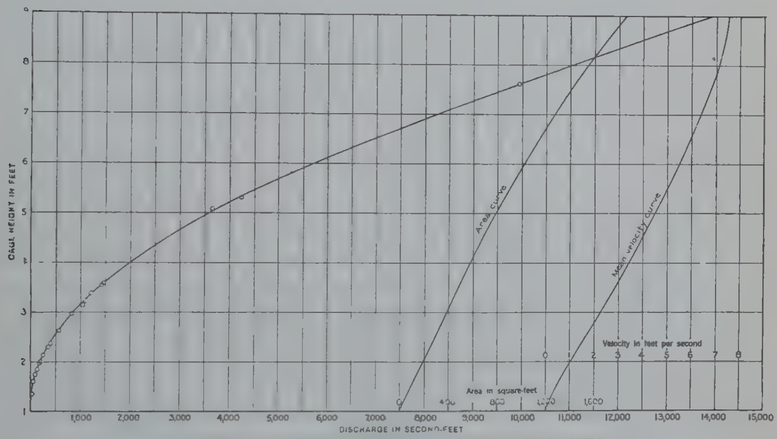
NOTE. This paper is published in advance of its presentation before the Society. Discussion is invited, to be received by the editor before January 10, 1917, for publication in a subsequent number of the JOURNAL.

* Chief Hydraulic Engineer, U. S. Geological Survey.

or the combination of conditions of channel below the gage which fixes the shape of the rating curve (that is, the rate of change of stage with relation to the discharge or the "sensitiveness" of a station) and the changeability or permanence in the stage-discharge relation, affects the accuracy of the interpretation of a record of stage into a record of discharge and determines the number of current-meter measurements of discharge needed for such interpretation. The importance of these fundamental conditions, though perhaps long recognized vaguely, is now more definitely comprehended and appreciated. The engineer of the future, who is to select the sites for gaging stations and direct their establishment and operation, must understand the relations of channel to the methods to be adopted, to the type of station to be used, and to the accuracy and cost of the records that may be obtained.

The utility of the current meter in measuring river discharge is limited to cross-sections of streams characterized by well-distributed velocity, ranging between a minimum of about 0.5 ft. per second and a maximum of say 15 ft. per second, and absence of eddies or cross currents.. The water must move in parallel filaments in order that the current meter may at all times lie in a plane perpendicular to the gaging section and may not be affected by currents moving in other directions. Cross currents and boils will cause errors in the recorded velocities, positive with some meters and negative with others. The lower limit of allowable velocity is fixed by the meter itself, which of course is not frictionless and requires an appreciable velocity of current for dependable action; the upper limit of allowable velocity is determined by the equipment used for holding the meter steadily in position in the water and by the ability of the observer to count or record revolutions of the meter.

The ratio of size and slope of channel to quantity of flowing water determines the amount of change in stage for a given change in discharge, or the "sensitiveness" of a gaging station; the greater the fluctuation in stage for a given fluctuation in discharge, the more sensitive the station. As stage is the function of discharge that is measured and recorded, either continuously or periodically, as a means of estimating daily discharge, it is necessary that the fluctuation of stage for the minimum change of discharge to be recorded shall be easily measurable on the gage used. This minimum change should, in general, be about one per cent. of the flow at any stage. If, therefore, a stream carries at low water 100 sec.-ft., a change in discharge of 1 sec.-ft. should cause a measurable change in stage. If the stream carries 1 000 sec.-ft., a measurable increase of stage for an increase in discharge of 10 sec.-ft. would be equally satisfactory. Obviously, a site for a station should be selected so as to give as large a change in stage as possible for a given change in discharge.

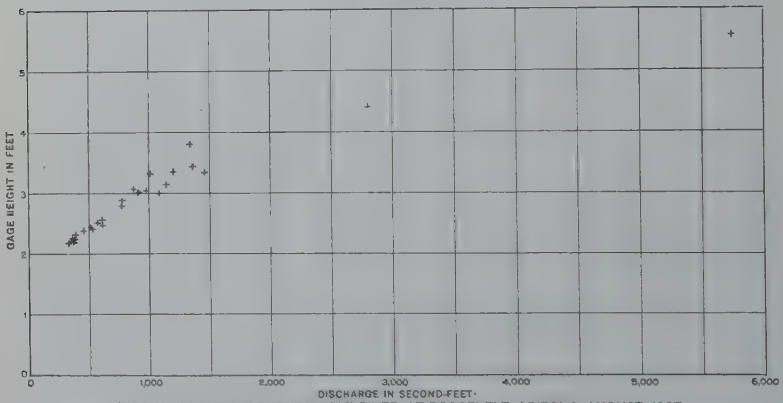


RATING CURVE FOR DEERFIELD RIVER AT CHARLEMONT MASSACHUSETTS

FIG. 1.

The choosing of a site for collecting systematic records of discharge involves much more than the finding of a sensitive cross section in which a good current-meter measurement of discharge can be made. Permanence of the stage-discharge relation and assurance that recurrences of the same stage correspond at all times to practically the same discharge are essential if dependable records of flow are to be obtained at a reasonable cost. If the stage-discharge relation is not permanent, a sufficient number of current-meter measurements of discharge must be made to serve as a basis for translating a record of daily stage into a record of daily discharge. Obviously, the number of such discharge measurements will vary from the few required to define a rating curve for a gaging station where the stage-discharge relation is permanent or where a change in that relation occurs definitely and only at considerable intervals of time, to the many, perhaps several each week, needed if the channel is constantly shifting.

The rating curve of Deerfield River at Charlemont, Mass. (Fig. 1), is well defined by a few current-meter measurements of discharge, and a good record of stage insures an acceptable record of run-off. This rating curve has not changed appreciably in four years, although current-meter measurements have been made each year, several different current meters have been used, and four engineers have made the measurements.



DISCHARGE MEASUREMENTS, SALT RIVER AT ROOSEVELT, ARIZONA, AUGUST, 1907

FIG. 2.

The measurements plotted on this rating curve show radical contrast with those made in a single year on Salt River at Roosevelt, Ariz. (Fig. 2), which illustrate the changeability of the stage-discharge relation and the futility of attempting to interpret a record of stage at this station without frequent current-meter measurements of discharge. Between the extremes illustrated by these two rivers are found all degrees of permanence of beds and banks, and each stream should be studied carefully to find the best available site for collecting records within the limit in cost imposed by the available funds.

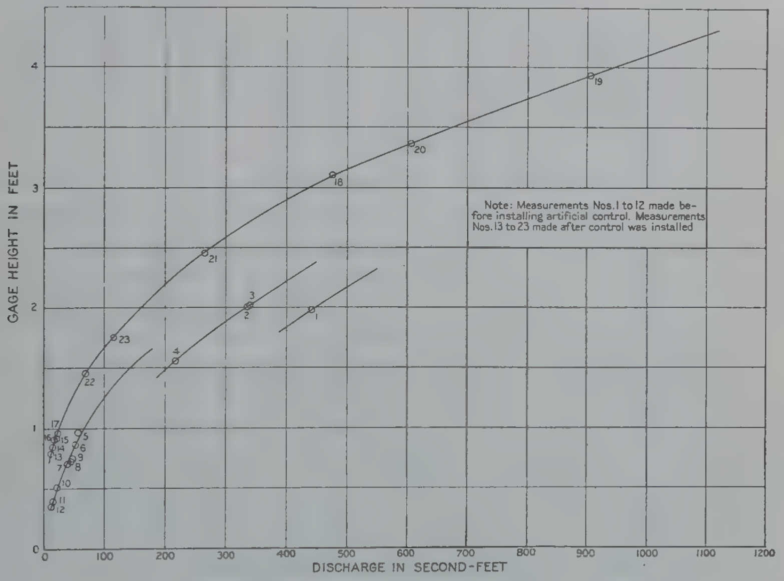
The ideal gaging station, combining uniform and measurable velocity of current at all stages, measurable fluctuation of stage for the minimum important fluctuation, and an absolutely permanent relation of stage to discharge for all stages, can seldom be found in stretches of a river for which records are needed or so near to railroads or highways or to residents who can be employed to assist in caring for the gage and in obtaining a record of stage that its rating and operation is practicable. The ability to select a site for a gaging station to yield records of a certain degree of accuracy or to chòose the best available site for collecting records in any limited stretch of stream channel is therefore of great importance. It is acquired only by experience, preferably in the same general region and with streams of the same type. Many factors that affect this relation must be carefully considered. The permanence of bed and banks *at the gaging section* may or may not be material. The rating curve of Ocmulgee River near Jackson, Ga., defined by measurements made in several years by different engineers using different current-meters, shows a permanence of relation of stage to discharge not discoverable by consideration of bed and banks at the gaging section, for the soundings made in connection with the measurements of discharge show that the bed of sand shifts greatly. The stage-discharge relation at this station is maintained by a reef or ledge extending entirely across the river a short distance below the station and at the upper end of rapids or shoals. This ledge acts as a submerged dam, and the relation of stage to discharge over it may be expressed as definitely as the formula of a standard weir, although of course complicated by a greater number of influencing factors. Because this ledge controls the stage-discharge relation, it is called the " control " of that gaging station. It is of course unusual to find a control so conspicuous as this one.

The term " control " as now used with reference to a gaging station may be defined as the ledge of rock, gravel bar, dam, stretches of banks and beds of greater or less length, combined with smoothness of bed, rate of gradient, shape of channel and various features causing backwater. Obviously the position, extent and character of the control for a site that is being considered for a gaging station cannot generally be ascertained with certainty by a single inspection, and it may be advisable to install a temporary gage and make measurements of discharge at different stages before incurring the expense of establishing a permanent station. In some sections of the country the possibility of backwater from jams of logs, ice or other drift must be considered. The danger of change in the stage-discharge relation due to the growth of aquatic plants is always present and extremely difficult to predict. When a control is affected by vegetation, the result is a gradual shift corresponding to a rising control during the season of growth, and a fairly sharp drop to normal conditions when the plants disappear in the autumn. Backwater from a tributary below a gaging station has an effect similar to that of a shifting control in a channel which otherwise may be permanent.

In recent years the Geological Survey has attempted the construction of "artificial controls" on small streams whose beds shift, as an essential part of the establishment of satisfactory gaging stations. These artificial controls are low dams, generally submerged, erected below the gaging stations in such manner as to control the flow past the stations. The effect of an artificial control on the rating of a gaging station on Logan River at Logan, Utah, with special reference to the stage-discharge relation, is shown by Fig. 3, in which the current-meter measurements of discharge made before the artificial control was constructed are numbered 1 to 12 inclusive and those made since the control was constructed are numbered 13 to 23 inclusive.

The essential features of an artificial control are (*a*) stability, (*b*) tightness, (*c*) sufficient height to serve as a control at all stages, (*d*) sufficient width (on some streams) to furnish a measuring section, (*e*) crest of such shape as to give a proper degree of sensitiveness to the station, (*f*) clear channel of approach, and (*g*) position near the gage.

Permanence of the stage-discharge relation is the principal object sought in constructing an artificial control. The structure itself must, therefore, be so built that it will be stable at all stages without serious danger of failure by undermining or washing around the end and that the crest will retain its elevation and shape under the severe conditions of abrasion pertaining to streams that carry large quantities of sand, gravel and even bowlders. The conditions for stability are those pertaining to a small dam. Abrasion of crest may be reduced to a minimum by a steel lip placed in the crest of a control. Such lip is most effective if placed near the downstream edge of the crest, where it will serve both to give a free overfall at low stages and to hold a cover of sand and gravel on the upstream slope for its protection.



Note: Measurements Nos. 1 to 12 made before installing artificial control. Measurements Nos. 13 to 23 made after control was installed

FIG. 3. RATING CURVE FOR LOGAN RIVER, AT LOGAN, UTAH.

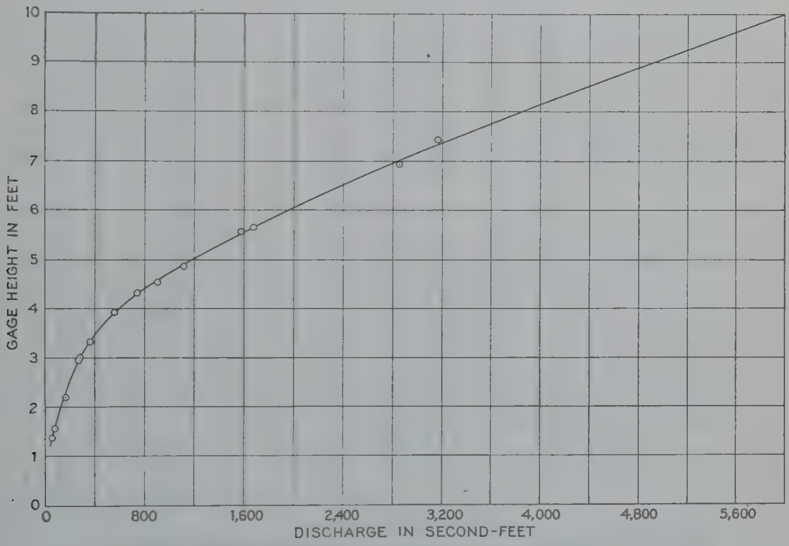
As an artificial control is constructed in order to make possible the collection of a good record of discharge by means of a record of stage, it is essential that practically all the water shall be forced to flow where it will affect the stage. If appreciable quantities of water can pass through or around a control in strata of sand, gravel, lava or other material, the control will not give satisfactory results.

The height necessary for an effective control varies with the size and slope of the stream at the control and the slope and other conditions of bed and banks below. The lower the control and the less the departure from the natural conditions of channel, the smaller will be the effect of running water in tearing down the structure and the cheaper will be its construction and maintenance. The height of an artificial control must be sufficient to prevent its drowning at medium and high stages by the backwater from a secondary and shifting natural control below. The smaller the slope of a stream and the more restricted and tortuous the channel below the control, the greater the height needed for efficiency. A stream of rapid fall below the control offers little chance for drowning of one control by backwater from a control below. The ratings for certain gaging stations shift only in the low-water sections. For such stations artificial controls of sufficient height to govern the stage-discharge relation throughout the range of shift will evidently accomplish the purpose as well as higher controls.

On many rough mountain streams it is difficult to find gaging sections at which reasonably accurate measurements of discharge, especially at low water, can be made. A section that is cleaned and made reasonably smooth may fill with bowlders during the next high water. On such streams it may be advisable to construct artificial controls with such width of crests, 12 inches or more, as to afford measuring sections.

The profile of the crest of an artificial control across the stream will determine the sensitiveness of the gaging station and therefore the accuracy of the record that can be collected. The greater the fluctuation in stage for a given change in discharge, the less the refinement needed in the record of stage to obtain the desired accuracy in record of discharge. A long, level spillway will create a pool which will fluctuate slowly and in which the stage must be recorded with great accuracy if reasonably accurate estimates of flow are to be made. The crest of an artificial control should therefore rise by steps or slopes from the lowest part, which may be in the center of the channel or near either bank, to the banks at a rate commensurate with the size of the stream and the accuracy of record desired.

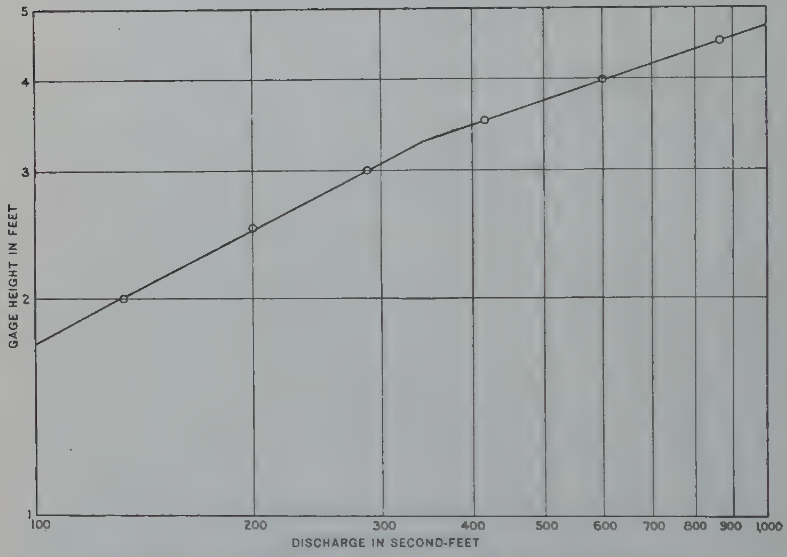
The channel of approach should be free from bowlders, débris or vegetation, in order that the artificial control may effectively maintain a permanent relation of stage to discharge at the gage. The control should be placed as near the gage as is practicable and at only sufficient distance from it to insurp that the gage shall at all stages be in still water above the share surface slope immediately above the control.



RATING CURVE FOR INDIAN CREEK NEAR CRESCENT MILLS, CALIFORNIA

FIG. 4.

The rating curve for a standard rectangular weir for which the formula for the discharge, $Q = Clh^n$, is parabolic, and will plot as a straight line on logarithmic cross-section paper. Similarly, a rating curve for a current-meter gaging station that is parabolic in form will appear as a straight line when *plotted* on logarithmic cross-section paper from the datum of zero flow. It has been proposed to use such cross-section paper for plotting rating curves that must be extended considerably beyond the stage for which current-meter measurements of discharges have been made. This method appears to be reasonably safe if the aspect of the cross section of the river at the control section or sections does not change within the limits of range in stage. There is danger, however, that with a decided change in aspect of cross section, the equation of the rating curve may change, and the rating curve which appears to be a simple parabola (Fig. 4) when plotted to natural scales becomes a broken line (Fig. 5) when plotted on logarithmic cross-section paper indicating a combination of parabolas. A straight-line extension of the low-water curve would then lead to gross error for high stages.

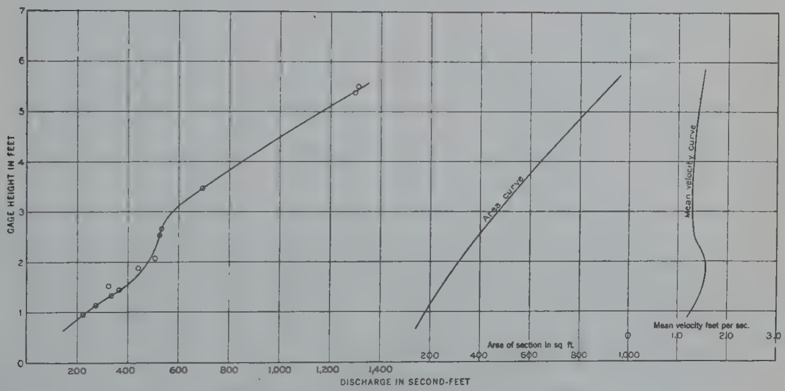


RATING CURVE FOR INDIAN CREEK AT CRESCENT MILLS, CALIFORNIA.
LOGARITHMIC SCALES

FIG. 5.

A transfer of control from one cross-section to another or from one section of river to another with changing stage may lead to similar changes in shape of the rating curve, changes that may or may not be apparent to the eye when plotted to natural scales. Frequently such transfer of control and the combination of rating curves resulting from the different controls lead to reversals in the rating curve that were for a long time enigmas to those engaged in stream gaging. The rating curve of Kickapoo River at Gay's Mills, Wis. (Fig. 6), shows a sharp reversal which was well defined by many measurements made in a series of years and with the greatest care. The peculiar shape of the curve led engineers to think that it must be in error and hence much care was used in all of the work. The rating curve of East Fork White River at Shoals, Ind., shows the same kind of a reversal, although somewhat less marked, and many similar instances could be cited.

If two standard weirs be placed in the same stream, the upper one 3 ft. long and the lower one 2 ft. long and 6 ins. lower than the first one, the rating curve for a gage placed in the pool above the upper weir must have a reversal at the stage where the lower weir drowns out the upper weir. Below a gage height of about 2 ft. the upper weir forms the control for the section of the gage; above that stage the lower weir forms the control.



RATING CURVE FOR KICKAPOO. GAY'S MILLS. WISCONSIN

FIG. 6.

No doubt many gaging stations are now operated at which the transfer of the control from one section to another with change in stage is disclosed by examination of the site or by study of the rating curve. Such transfers in control may explain the cause of a change that appears in one part of a station rating curve while other parts of the curve are permanent.

The selection of a site for a satisfactory gaging station involves, therefore, a careful study of the river channel not only in the immediate vicinity of the site proposed but also for a distance below, varying from a few hundred feet to several miles. This examination must be sufficiently thorough to disclose the facts as to the gaging section, the sensitiveness of the site, especially at low stages, and the shape and permanence of the control. Under some conditions of channel, the controlling factors may be so obvious that an inspection of the site at a low stage of the river would disclose, with reasonable certainty, the characteristics of a gaging station established there; under other conditions several inspections at different stages of the river may be needed; and under still others it may be necessary to install a gage and try out a site for several weeks or months by recording daily stage and making several current-meter measurements of discharge at different stages before safe decision can be reached as to the character of record that may be obtained.

On the character of channel depends largely the cost and accuracy of a record obtained at any site. The gaging section will determine largely the accuracy of current-meter measurements and therefore the accuracy of the rating curve. The shape of the control will determine the sensitiveness of the station and therefore the accuracy with which a record of stage may be translated into a record of discharge. The permanence of the control will determine the permanence of the stage-discharge relation and therefore the dependability of the rating curve and the number of current meter measurements required as a foundation for the rating curve or succession of rating curves needed for interpreting the record of stage.

MEMOIRS OF DECEASED MEMBERS.

EDMUND K. TURNER.*

EDMUND K. TURNER, for many years a leading member of the engineering profession, died at the Corey Hill Hospital, Brookline, after a short illness, on May 6, 1915.

Mr. Turner was born in Marblehead, Mass., May 11, 1848. His father, Joseph P. Turner, was for many years cashier of the National Grand Bank of that town. His mother, who died when he was a child, was Mary K. Kimball, of Marblehead.

In September, 1867, he entered the Massachusetts Institute of Technology, which had only just been started, and from which the first class had not yet been graduated. He chose the course in civil engineering, from which he graduated in 1870. He showed great ability and diligence in his work at the school, and by his high scholarship and his manly character he won the esteem of his teachers and classmates. He early took an interest in military work and was all his life an earnest believer in the efficacy of strict discipline. Military drill was at that time, as at present, one of the requisites in the course of study at the Institute, and Mr. Turner became one of the captains of the Institute battalion.

After leaving the Institute he was at once engaged as engineer of construction of the Nashua, Acton & Boston Railroad, a short line now a part of the Boston & Maine system. On the completion of this work, he was appointed chief engineer of the Fitchburg Railroad, a position which he held for about eighteen years. During a portion of this time he was also assistant superintendent of the Vermont and Massachusetts Division of the Fitchburg Railroad, thus gaining an experience in railroad operation as well as in railroad construction and maintenance.

About 1890 he resigned his position as chief engineer of the

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* Memoir prepared by George F. Swain.

Fitchburg Railroad and entered upon private practice as a consulting engineer in Boston, in which he continued up to the time of his death.

In 1895 he became consulting engineer for the Massachusetts Board of Railroad Commissioners, on various problems in connection with the construction of the Boston Elevated Railway, the appraisal of railroad and street railway properties, and other matters. He continued to serve the Commission in matters of this kind up to within a short time previous to his death.

In the course of his practice as consulting engineer, Mr. Turner served on many important commissions appointed by the courts, as provided by statute, for the purpose of deciding on plans for the abolition of grade crossings throughout the state of Massachusetts. Probably no engineer in New England has had as large experience in work of this kind as he had. He was also consulting engineer for the Fitchburg Railroad Company and made annual inspections of that property and advised its officers with reference to maintenance and needed improvements.

Mr. Turner joined the American Society of Civil Engineers in 1891 and was a Director of the Society from 1899 to 1901. He was also a member of the Institute of Consulting Engineers and of the Boston Society of Civil Engineers, which latter society he joined in 1874.

Mr. Turner was one of the best-informed engineers in the country on transportation matters, and he brought to the consideration of those subjects not only a wide knowledge and extensive experience, but a well-balanced judgment, which led him to see at once to the root of the matter and to disentangle the main question from all relatively unimportant details. His knowledge covered not only American practice, but European practice as well, and during nearly a quarter of a century he made annual trips abroad for study, observation and recreation. He was also well read in a wide range of subjects, and a lover of art and music, and especially of all that is beautiful in nature.

The soundness of Mr. Turner's judgment is shown by the esteem in which he was held by members of the legal profession with whom he had occasion to work in connection with the various grade-crossing commissions upon which he served, the other members of which were generally lawyers. One of his friends in the legal profession writes as follows regarding less known services not in the engineering line:

> "Entirely apart from Mr. Turner's services in the strict lines of his profession, he was much sought after by his friends and others for advice on legal and business matters and on affairs of property interests. His selection as executor of the William C. Todd estate, involving a very considerable sum of money given for educational purposes and as to which there were several legal controversies, is an illustration of how he was regarded by one of the early business men of New England. Those who had occasion to consult him always obtained a sympathetic hearing and definite advice that was always honest and sound, though perhaps not always in accordance with their desires."

Mr. Turner was of reserved demeanor, undemonstrative and somewhat difficult to become acquainted with, but he was much beloved by those who really knew him, and respected by all with whom he came in contact, including his employees when chief engineer of the railroad company. He was a strict disciplinarian, not only with others, but with himself, but absolutely just in all his judgments. There was nothing indefinite about Mr. Turner. If you asked him a question, you always obtained a definite answer and found out exactly what he thought, even if it did not agree with your ideas or desires. These qualities made him an excellent witness, and in the course of his professional experience he had many occasions to appear before courts or other legal tribunals.

Mr. Turner's death will be a great loss to the engineering profession. There are not many men in any profession with his sturdiness and independence of character, his modesty and his attainments. Those who knew him well will, in addition, feel a sense of personal loss in his passing and will long remember his many admirable qualities.

EMORY ALEXANDER ELLSWORTH.*

DIED DECEMBER 8, 1915.

EMORY ALEXANDER ELLSWORTH, the son of John F. and Maria (Lawrence) Ellsworth, was born at Hardwick, Mass., August 3, 1853. He was educated in the public schools of his native town and graduated from the Massachusetts Agricultural College in the class of 1870, which was the first graduating class to leave this institution.

After his graduation, Mr. Ellsworth was employed by E. E. Davis, civil engineer, of Northampton, Mass. One of the big jobs he had charge of while assistant to Mr. Davis was the installation of a new municipal water supply for the city of Holyoke, which was completed in 1874. Shortly afterwards Mr. Ellsworth formed a partnership with F. E. Davis, nephew of his former employer, the firm opening an office in the city of Holyoke under the name of Davis & Ellsworth.

In 1879 Mr. Ellsworth left the firm of Davis & Ellsworth to become principal assistant and head draftsman for D. H. & A. B. Tower, of Holyoke, who were the largest firm of paper mill architects in the country at that time, and who designed no less than twenty paper mills in the city of Holyoke alone.

In 1883 Mr. Ellsworth resigned his position with D. H. & A. B. Tower and went into private practice for himself as engineer and architect, opening an office in Holyoke, which he retained uninterruptedly until his death. In 1899 he took into partnership John J. Kirkpatrick, and in 1907, when Mr. Kirkpatrick left the firm to be superintendent of the Holyoke Water Works, Lyman J. Howes became a member of the firm of Ellsworth & Howes and was so connected at the time of Mr. Ellsworth's death.

Besides attending to his private practice, Mr. Ellsworth was city engineer of Holyoke for the years 1884, 1885, 1887, 1888 and 1889. Among the larger works done by him in this capacity were the Whiting Street and Bray municipal reservoirs.

From the very start after opening his office in 1883 until his death, Mr. Ellsworth had a large practice, both as engineer and architect, throughout New England, New York and Canada. His practice covered the design and construction of numerous paper mills and other industrial establishments, public buildings, apartment houses and private residences, installation of water supplies and water powers, dams and sewerage systems, etc.

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* Memoir prepared by James L. Tighe and A. H. Lavalle.

Mr. Ellsworth was twice married. His first wife was Lucy J. Bradford, of Northampton, Mass., and his second, Carrie Meach, of Holyoke. With his first wife he had two sons and a daughter, all of whom, together with his second wife, survive him.

Mr. Ellsworth was a man of very gentle, retiring and modest manner, high integrity, thoroughly honest in everything, and kind-hearted in the extreme. He had a most equitable temperament, and, as a proof of this, it is only necessary to state that of the numerous assistants whom he employed and who were under his charge during his forty-five years of practice, not one of them ever knew him to lose his temper or show any irritation, even under the most trying circumstances. He was always most considerate, in fact, indulgent, towards his help, who all remember his genial personality and kindness of spirit.

SAMUEL FOSTER JAQUES.*

Samuel Foster Jaques was born in Newburyport, Mass., on November 29, 1865. He was the son of Edmund and Rachel (Foster) Jaques, both descendants of the country's early settlers. His accidental death occurred in Binghamton, N. Y., on January 8, 1916, as the result of a fractured skull which he sustained by being thrown headlong from his motorcycle to a brick pavement when the machine skidded on a street car-track. He never regained consciousness after his fall and expired in a hospital three hours later.

Mr. Jaques was educated in the public schools of Newburyport and then started to learn the engraver's trade. In 1886 he entered the Massachusetts Institute of Technology, where he remained two years. From 1887 to 1891 he was with Wm. H.

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* Memoir prepared by William Nelson, Harrison P. Eddy and F. Herbert Snow.

Whitney, of Boston, Mass., and from there went South to Tennessee and Georgia on engineering work. During 1892 he was engaged on preliminary sewer work in Brockton, Mass., and after a short engagement with Aspinwall & Lincoln, of Boston, in 1893, he returned to Brockton.

In 1894 Mr. Jaques entered the engineering service of the United States Government at Portland Head, Me., and went from there to Dover, N. H. During 1895 he was in the employ of F. Herbert Snow, then city engineer of Brockton, Mass. In 1896 Mr. Jaques was with George A. Kimball on sewer construction in Arlington, Mass., and with Percy M. Blake in 1897–98, at Hyde Park, Mass.

From 1898 to 1903 Mr. Jaques was in the city engineer's office at Worcester, Mass., and from there went to Dover, N. H., where he was engaged in private engineering practice until 1905.

He went to Lestershire, N. Y., to construct a sewer system for Morrison & Farrington, of Syracuse, N. Y., and entered the employ of the city of Binghamton, N. Y., as assistant city engineer in 1905, which position he held until his untimely death.

Mr. Jaques joined the Boston Society of Civil Engineers in 1903. He was a member of the Binghamton Engineering Society; Binghamton Lodge No. 77, F. & A. M.; Binghamton Chapter No. 139, R. A. M., and Malta Commandery No. 21, Knights Templar. In his religious life he was a Congregationalist, and was a very active and faithful worker in the church.

He was a man of quiet tastes, and was very devoted to his family and profession. Uniformly kind, courteous and considerate of others, he enjoyed a wide circle of friends.

Mr. Jaques married Abbie P. Noyes, of Newburyport, Mass., on September 12, 1893. He is survived by his wife, one daughter, Mildred Noyes Jaques, both of Binghamton, and one brother and one sister of Newburyport, Mass. The funeral services were held in the Old South Chapel, and interment was made in Oak Hill Cemetery, Newburyport.

CHARLES W. ROSS.*

Charles Wilson Ross was born in West Boylston, Mass., March 8, 1849, and was educated in the public schools of that town and at Worcester.

His father, William J. Ross, was a builder, but passed many years of his life on a farm in West Boylston. He was an inventor of some note. Among his inventions was a winnowing and threshing machine and a sulky plow. The son inherited an inventive genius, which was turned to good account during his active life, although practically no effort was made to reap a financial reward from it, as whatever improvements he made were given freely to the public.

He remained at home during his boyhood days, working with his father as a builder and willingly performing the manifold duties devolving upon him during his farm life. Accustomed to long days and hard work, Mr. Ross left the farm in 1869 endowed with all of those sturdy qualities of the pioneers "who brought forth on this continent a new nation."

With firm muscles, inventive genius, good nature and a willingness to work, he found no difficulty in quickly securing a good position where such qualifications were in demand.

His first employment was in the Newton Cemetery, where he soon was promoted to the position of assistant superintendent. He remained there for twenty-one years, when he resigned to accept a position of public trust, being appointed superintendent of streets of Newton, Mass., December 8, 1890. When the revised city charter of 1897 became effective in 1898, he was appointed street commissioner and took under his charge all work relative to the public ways, bridges, parks, playgrounds, burial grounds, street lighting, sewers and drains, and continued to hold that position until April 15, 1914. During the years 1905 to 1908 he also had charge of the gypsy and brown-tail moth suppression work.

His administration, covering a period of twenty-four years, was honest, progressive, efficient and economical. Never a suspicion existed that he failed in any way to conduct the different departments under his charge for the best interests of the city, without fear or favor.

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* Memoir prepared by Wm. E. McClintock, Edwin H. Rogers and George E. Stuart.

Shortly after his appointment he discarded the old and costly methods of building streets and adopted the plan of using a thin coating of screened broken stone spread over the old gravel roads and finishing with a steam roller to give a hard, smooth surface. He was the first street superintendent in the country to make this radical departure. In a few years, under Mr. Ross's direction, the streets of Newton attained the reputation of being the best of any city in the country, and they maintained that reputation throughout his administration. When Mr. Ross began to note the destructiveness of automobiles he tackled the problem with the same spirit as he did the broken stone roads years before, and solved it in an equally satisfactory manner.

In July, 1898, Mr. Ross was appointed a member of the Massachusetts Highway Commission by Governor Crane, which position he held for two years until compelled to give it up because of the increased demand upon his time by the city of Newton, where he was serving as street commissioner at the same time. With a ripe experience acquired by many years on similar work he was an invaluable member of the Highway Commission, and much of the credit for the splendid system of Massachusetts state roads is due to his observations and timely suggestions.

His never-failing good nature made friends for him wherever he went. His advice on methods of caring for the common roads was of inestimable value to the road masters of cities and towns in all parts of the state. He was loyal to the Commonwealth and at all times insistent that she was entitled to the best at the least possible cost. With his warm heart and sunny smile Mr. Ross was beloved by his colleagues and every employee both in the field and office.

Mr. Ross and Mr. Richard A. Jones, of Waltham, took the initiative steps to organize the Massachusetts Highway Association. At one time he was president. He always took a deep interest in its affairs, attended all the meetings, and was ever ready to read an experience paper and discuss methods of building. He was known to road builders in all parts of the country, as he took the time to attend many of the state and national conventions.

Mr. Ross was a member of the First Baptist Church of Newton Centre. While he talked but little upon religious subjects, he was loyal to his church, and those most intimate with him never heard a word or witnessed an act which intimated that he did not accept the teachings of the Great Master and apply them in a practical manner.

Those who were admitted within the inner circle were charmed with the natural simplicity of his home life, where mutual love and warm-hearted consideration reigned supreme. Three and a half years ago Mrs. Ross was stricken with severe illness which rendered her entirely helpless. During all those years the fond husband has cheerfully responded to every call for care and sympathy, ever hopeful that a change for the better might come.

In 1914, wearying of the increasingly exacting duties as street commissioner, after twenty-four years' service Mr. Ross resigned the office and accepted the position as superintendent of the Newton Cemetery, which he held at the time of his death, April 12, 1916.

The fact that he passed the forty-seven years of his active life, after leaving home, in the service of either the Newton Cemetery or the City of Newton speaks louder than words of his ability and of his even disposition.

Mr. Ross married Miss Ella R. Gould, and is survived by her and five children: Mr. H. Wilson Ross, of Worcester; Mr. George W. Ross, of Boonton, N. J.; Mrs. Edward E. Lothrop, of Worcester; Mrs. Arthur Hodges, of Newton Centre, and Mrs. Edward E. Savory, of Auburndale; also by two brothers and a sister, Leonard W. Ross, superintendent of Boston Cemeteries; Walter D. Ross, president Ross Bros. Co., Worcester, and Mrs. Handy, Montclair, N. J.

Mr. Ross was a Mason, being a member of Dalhousie Lodge, A. F. & A. M., and Newton Chapter, Royal Arch Masons, of Newtonville, and held membership in the Massachusetts Highway Association, Massachusetts Horticultural Association, American Park Association, National and New England Associations of Cemetery Superintendents, Boston Society of Civil Engineers, and was an Associate of the American Society of Civil Engineers.

Vol. III NOVEMBER, 1916 No. 9

BOSTON SOCIETY OF CIVIL ENGINEERS

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INDEX TO ADVERTISERS.

	Page
A. B. See Electric Elevators, 111 Devonshire St., Boston	XVI
Aberthaw Construction Co., 8 Beacon St., Boston	XV
Adams, H. S., 108 Ames Building, Boston, Mass.	IV
Aspinwall & Lincoln, 3 Hamilton Pl., Boston	IV
Associated Architects Printing & Supply Co., 144 Congress St., Boston	XVII
Bay State Dredging Co., Ltd., 247 Atlantic Ave., Boston	X
Bishop, J. W., & Co., 683 Atlantic Ave., Boston	XI
Blair, Isaac, & Co., Inc., 433 Harrison Ave., Boston	XI
Bond, Harold L., Co., 383 Atlantic Ave., Boston	XIV
Buss, Edward A., 85 Water St., Boston	IV
Coleman Bros., 1 Marginal St., Chelsea	XIV
Detroit Graphite Co., 94 Milk St., Boston	XVII
Dixon Crucible Co., Jersey City, N. J.	XVII
Eastern Bridge and Structural Co., Worcester	XVI
Fay, Spofford & Thorndike, 308 Boylston St., Boston	IV
Fort Hill Press, 176 High St., Boston	XVI
Fuller, George W., 170 Broadway, New York	IV
Gow, The Charles R., Co., 166 Devonshire St., Boston	XIII
Hall, John G., & Co., 114 State St., Boston	XVII
Harrington, Ephraim, 20 Pemberton Sq., Boston	IV
Hern, J. L., Engineering Co., 149 Pearl St., Boston	IV
Hersey Mfg. Co., South Boston	XVIII
Holbrook, Cabot & Rollins, Corpn., 6 Beacon St., Boston	VII
Holzer, U., 25 Bromfield St., Boston	X
Hughes, Edward F., 8 Oliver St., Boston	XVII
Jackson, D. C. & Wm. B., 248 Boylston St., Boston	IV
Jonsberg, F. F., Co., 733 Old South Building, Boston	XI
Ledder & Probst, 56 Franklin St., Boston	XIV
Main, Charles T., 201 Devonshire St., Boston	III
Makepeace, B. L., 12 Bromfield St., Boston	II
Metcalf & Eddy, 14 Beacon St., Boston	IV
Miller, William L., 71 Alford St., Boston	VIII
Moss, Charles E. Co., 38 Broad St., Boston	XIV
New England Bureau of Tests, Inc., 12 Pearl St., Boston	V
New England Sand & Gravel Co., West Peabody, Mass.	VIII
Old Corner Book Store, 27 Bromfield St., Boston	XVII
Palmer, John E., 1012 Old South Bldg., Boston	XVII

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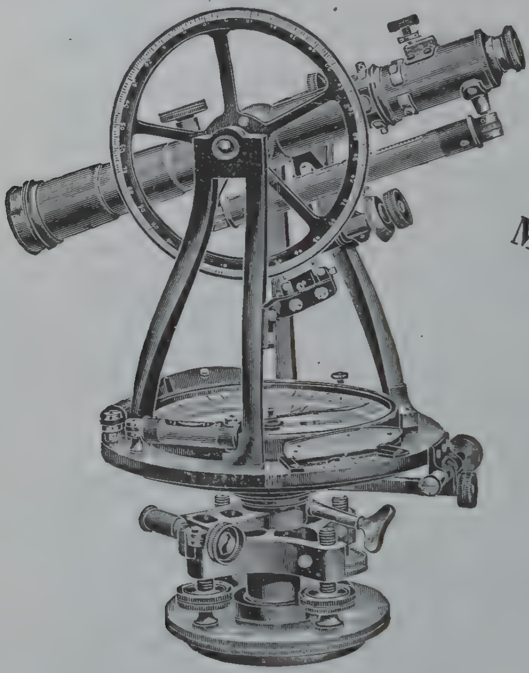

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Page
Pennsylvania Cement Co., 161 Devonshire St., Boston xi
Perrin, Seamans & Co., 57 Oliver St., Boston xvii
Rideout, Chandler & Joyce, 178 High St., Boston xiv
Rockport Granite Co., Rockport, Mass. vi
Simpson Bros. Corpn., 166 Devonshire St., Boston vi
Smith, B. F., & Co., 60 Federal St., Boston xiv
Spaulding Print Paper Co., 44 Federal St., Boston xiii
Stone & Webster, 147 Milk St., Boston ix
Thompson, Sanford E., 141 Milk St., Boston iv
Thorpe, Lewis D., 201 Devonshire St., Boston iv
Tucker, Edward A., Co., 683 Atlantic Ave., Boston vi
Waldo Brothers, Boston x
Warren Brothers Co., 142 Berkeley St., Boston xii
Warren Foundry and Machine Co., 111 Broadway, New York viii
Weston, Robert Spurr, 14 Beacon St., Boston v
Wheeler, Charles D., 65 Kilby St., Boston xiii
Whitman & Howard, 220 Devonshire St., Boston v
Wood, R. D., & Co., Philadelphia viii
Worcester, J. R., & Co., 79 Milk St., Boston v

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